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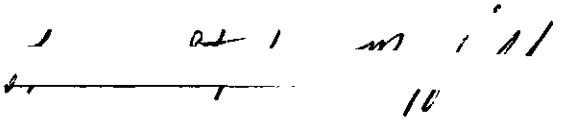

PLANNING FOR ELECTRIC POWER FACILITIES IN URBAN AREAS

A THESIS

Presented to

The Faculty of the Graduate Division

by

Lance Stephen Mayfield

In Partial Fulfillment

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The author dedicates this thesis to his wife, Margaret, whose assistance and encouragement made this graduate study possible.

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SUMMARY

The purpose of this study is to determine how the urban planner and electric utility planner may cooperate in locating electric power facilities in urban areas. The electric facilities examined are power plants, transmission and distribution lines and substations. Three aspects of these facilities are discussed: (1) their operation; (2) their regulation; and (3) methods of joint planning.

A generating power plant in an urban area has significant effects on surrounding land. The transmission system with its tall towers and rights-of-way occupy a considerable amount of land and are objectionable to many for aesthetic reasons. The distribution system, consisting of the familiar overhead lines, wooden poles and transformers, is also aesthetically displeasing to many. Transmission and distribution substations are located on individual lots normally ranging in size from 1/4 to 1-1/4 acres. Substations make an audible humming sound and can be objectionable in a residential area.

Electric utilities are closely regulated at the Federal, State and local levels. However, the strongest controls over the location, installation and operation of electric facilities are exercised at the local level. The principal local controls are the franchise, zoning ordinance, special ordinance or resolution regulating lines, subdivision regulations, and the official map.

The franchise authorizes the utility to operate in the municipality and use public street rights-of-way for its facilities. Zoning

normally is concerned with electric power plants and substations. The special ordinance or resolution is primarily used to control the placement of wires and poles for the safety and convenience of the public. Subdivision regulations may specify where easements for electric facilities must be located in new developments. The official map, if state enabling legislation is adequate may be used to reserve transmission rights-of-way and substation sites.

The urban planner and electric utility planner should cooperate in selecting the location of power plants, transmission lines and substations. The urban planner can assist in: (1) making studies of the effects of proposed electric facilities on surrounding land; and (2) projecting where, of what type and when urban development will occur. The urban planner should also help develop policies for the placement of distribution facilities underground as well as policies dealing with an area that is annexed by the city and served by a different electric utility from that serving the city.

CHAPTER I

INTRODUCTION

This study was undertaken to determine how the urban planner and the electric utility engineer and planner may cooperate in locating electric facilities in the urban community.

To accomplish this goal it is necessary to acquaint the urban planner with the technical operation and governmental controls of electric facilities. Planners are typically poorly informed and indifferent about electric utilities. William L. Slayton, Commissioner of the Urban Renewal Administration, recognized this problem and suggested a change of attitude when he stated:

> Too often . . . local planning agencies lack the technical skills needed to appreciate system growth and operating problems of local electrical utility companies. This negative attitude of local planning agencies toward installations of utility systems is based on the concept of all utilities as "necessary evils," inevitably representing potential blighting factors. A more positive attitude involving joint planning and design with utility companies, rather than resigned tolerance, would produce better results in urban environment.[1]

The electric utility planner should also be better informed about urban planning processes and operations. This knowledge will aid in planning and designing a more suitable electrical system for the community. The understanding will also foster cooperation with the urban planner and will ultimately result in superior electrical service for the public.

Information for this study was obtained by: (1) an extensive search of available literature; (2) interviews with electric utility engineers and officials, city engineers, and urban planners; and (3) correspondence with city planning agencies and national electrical associations.

The facilities whose operation and location requirements are studied in this thesis are the:

1. electric generating power plant;
2. electric transmission system;
3. electric distribution system; and
4. electric substation.

These components of the electric system were selected because they are customarily or frequently located in urban areas, and they have a significant effect on surrounding land use.

Chapter II of this thesis describes the basic operations of the functional components of an electric utility system. The third chapter outlines the possible legal and administrative regulation of electric utilities. Chapter IV discusses some engineering and planning studies that will be of benefit in properly locating electric facilities in urban areas.

CHAPTER II

ELECTRIC POWER SYSTEM OPERATION

"Broadly speaking, an electric power system can be defined to include a generating, a transmission, and a distribution system."[2] The generating system consists of a power plant to generate electricity. The transmission and distribution systems contain equipment for transmitting electricity from the power plant to the consumer. Substations are essential in both the transmission and distribution systems.

A simplified written description and graphic portrayal of the electric utility system's functional components is given here as background for the more detailed descriptions which follow.

> . . . There must first be a source of electrical energy; this is provided in the generating stations, where so-called "generators" receive energy from their driving source, or prime movers, and convert it into electrical energy. . . . A transmission system is . . . required to connect the generating station, where the electric energy is developed, to the customer, where the energy is utilized.
>
> In any large system, this transmission system is not a simple, direct run of wires extending between the generating station and the utilization point; substations intervene to act as secondary distributing points. . . . Thus, there is the primary transmission system which connects the substations to the generating station and the secondary distribution system, which connects the substation to the customer. The secondary system, may, in turn, be divided into two systems separated from each other by distribution transformers. All this is done to secure the best efficiency, convenience, and safety in transmitting the electrical energy from the generating station to the consumer.[3]

This chapter will discuss, in non-technical terms, the following electric power system facilities: (1) power plants; (2) transmission

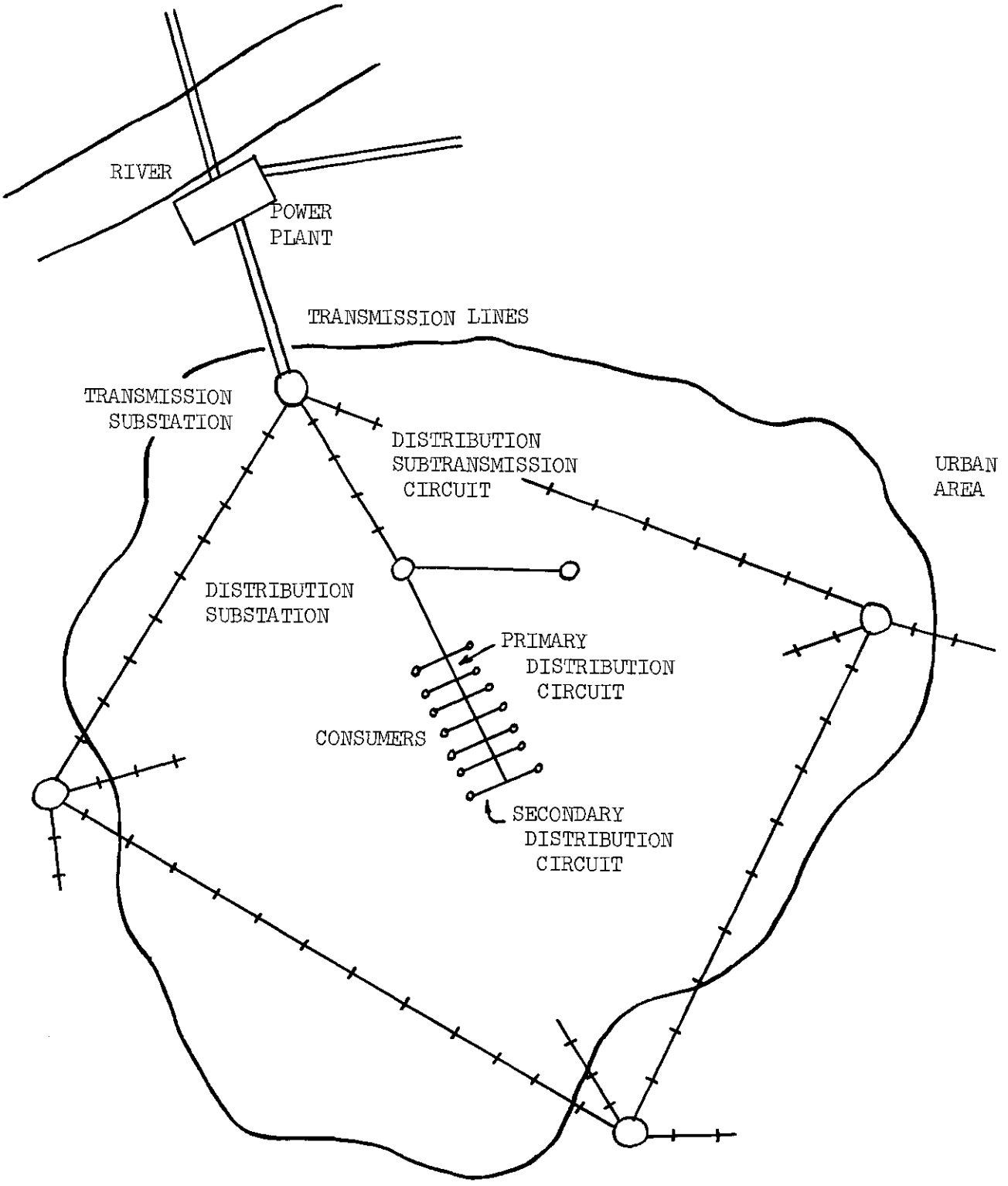

Figure 1. Functional Components of an Electric Power System.

lines; (3) distribution lines; and (4) substations.

Power Plants

Using long-range forecasts, the electric utility can usually forsee the need for a generating power plant approximately ten years in advance. This much lead time allows the utility to determine where the plant should be located. A power plant may be located either in a remote area some distance from the load center or near the load center in an urban area. Both locations offer advantages and disadvantages.

A remote location of the power plant generally involves cheaper land, fewer objections from nearby property owners and lower operating expenses. In addition, the remote plant may be nearer the fuel source and therefore require less cost for transportation of fuel. However, the remote location necessitates extensive and costly transmission lines and facilities to the load center. A lengthy transmission distance results in voltage or power losses.

The urban location of a power plant: (1) minimizes the voltage or power losses by reducing the distance from the power plant to the consumer; and (2) reduces the need for an extensive transmission system. However, satisfactory sites of sufficient size for the majority of power plants are rarely available in urban areas. If a satisfactory site is found, the high land costs, heavy taxation, and neighborhood objections to a power plant may make use of the site impractical. These factors generally make it more feasible and economical to locate some distance from the load center and transmit the electricity rather than pay the high costs inherent in an urban location.

Although a power plant is not often located in intensely developed urban areas, the power plant is discussed in the thesis because of its tremendous effect on surrounding land use if placed in an urban area.

Electricity is generated at power plants at an alternating current frequency of 60 cycles and from 2.3 kv (2,300 volts) to 20 kv. The basic operations of all power plants are essentially the same. First, the power plant uses equipment to transform chemical or kinetic energy (energy of motion) to mechanical energy. The chemical energy is either in the form of coal, gas, oil, or atomic matter and the kinetic energy is in the form of moving water. Second, the mechanical energy is transformed to electrical energy by a rotating device, an alternating current generator or alternator.

Numerous types of power plants are in operation by public and investor-owned electrical systems. The following table lists the types of power plants, their generating capacity and percentage of optimum power production by each type for the total electric utility industry in the United States in 1964.

Table 1. Types and Generating Capacity of Power Plants in the U.S.A., 1964.[4]

Type	Generating Capacity	Percentage
Steam-Fossil Fuel	175,137,800 kilowatts	79.0
Steam-Atomic Fuel	1,169,200	0.5
Hydroelectric	41,961,000	19.0
Internal Combustion	3,299,000	1.5
Total Electric Capacity	221,567,000 kilowatts	100.0

Steam-Fossil Fuel Plants

Most steam generating plants convert the thermal energy of coal, natural gas, or oil to electricity. The conversion process is accomplished by burning the fuel to produce steam. The steam under pressure drives turbine generators which produce the electricity.

The choice of fuel used in steam plants is determined by economic, engineering and operational factors.[5] At the present time, coal is utilized by the largest number of plants, with natural gas a distant second. Oil provides only a small percentage of the total amount of fossil fuel for steam generating plants.

Some steam plants are designed to burn several kinds of fossil fuels and to change fuels on short notice to take advantage of fuel market opportunities.

Steam plants produce almost 80 per cent of the total electrical energy generated in this country. The cheaper cost of operation is the primary reason for the reliance on steam power. However, the percentage of electricity generated by steam plants varies in different sections of the country. It ranges from more than 90 per cent in the Northeast to less than 40 per cent in the West.[6]

Steam power plants usually provide the bulk of an electric system's "base load" or constant demand for electricity. A steam plant is ideally suited for this because: (1) it can generate a large amount of electricity; and (2) it can be very economically operated to produce a constant amount of electricity for 24 hours a day. Other types of generating plants or additional steam plants can be placed in

operation to supply "peak" or large power and emergency power demands.

A steam plant requires large amounts of water for cooling (in the neighborhood of 500 million gallons a day) and is generally located on a site adjacent to a large body of water. However, in some cases, recirculating water in reservoirs, ponds or cooling towers will suffice.

An adequate rail, water or pipeline transportation system is essential to supply the fuel for fossil burning plants.

The site size for a steam plant may vary from an approximate minimum of 15 acres to a maximum of about 1,000 acres. Sites for plants burning coal must be at least 25 acres to provide sufficient space for storing a 30-to 90-day supply of coal.

Steam power plants cause thermal pollution problems because of a temperature rise in the water used for cooling condensers in the plant. This pollution adversely affects the aquatic life of the water body, its waste assimilation capacity, and the value of the water for municipal, industrial, and recreation uses.[7] Those plants using coal are particularly obnoxious in urban areas because they discharge large amounts of residual fly ash into the air.

Steam-Atomic Fuel Plants

Atomic-electric generating plants are steam plants which use atomic matter as a fuel source. The atomic power plant is discussed separately because its effects on surrounding land use and the Federal regulations governing the location of such plants are significantly different from those of conventional power plants.

In September, 1964, there were 14 atomic plants in full-scale operation and two plants were in the operational testing stage. Eleven

more plants were under construction or being designed.[8] Although still controversial, it is claimed by some that atomic power plants can now compete economically with conventional power plants in high-fuel-cost areas and that they can be operated safely in the heart of cities.[9]

The Consolidated Edison Company of New York had plans to construct and operate a nuclear power plant at Ravenswood, in the heart of New York City. However, adverse public reaction caused the company to abandon the project before the safety of the plant was investigated.[10]

Several atomic plants are located very near urban areas. The Enrico Fermi Plant at Lagoona Beach, Michigan, near Detroit, is an example. The Humboldt Bay atomic power plant is within four miles of Eureka, California, a city of about 30,000 population.[11] The nuclear plant proposed by the Los Angeles Department of Water and Power at Malibu Beach, California, is 29 miles from the Los Angeles City Hall and only 10 miles from Santa Monica.[12] In the future, it is likely that additional atomic-electric plants will be located in or near urban areas.

Steam-atomic power plants, like fossil fuel plants, require large amounts of water for cooling purposes. Therefore, a site located adjacent to a large body of water is necessary. Sites for atomic plants conceivably could be quite small, perhaps only 15 acres. However, all operational atomic plants are located on sites of at least 100 acres.

Hydroelectric Power Plants

Hydroelectric power plants utilize the kinetic energy (energy of motion) in moving water or water under pressure. The water turns turbines attached to generators to produce electricity. Dams or high falls are necessary to create sufficient head (pressure) to give force to the

flow of water. If a dam is constructed, it is desirable that it create an adequate size reservoir with enough water storage to allow year-round generation.

Hydroelectric plants are sometimes used to furnish the base-load power of electric systems. More often, however, because they can be quickly "brought on the line" to produce at full capacity, they are used to furnish emergency and peak power.

Most dams now being planned or constructed for hydro generation purposes are also designed for flood control and navigation. In addition, the reservoir created furnishes recreational opportunities.

The hydro plant, of course, can only be built on a stream or river in conjunction with a dam, or high falls. When there is a dam, the hydro generating facility may be located in the dam itself or downstream in a separate structure. With a waterfall, some of the stream water is diverted and funneled through huge pipes called penstocks to the bottom of the falls where the generating facility is located.

Hydroelectric plants cause no serious problems even if located in urban areas. A hydro plant does not increase the water temperature and thus cause thermal pollution nor does it contribute to air pollution. In addition, the dam and reservoir normally associated with the hydro plant provide associated benefits, such as recreation, water supply, fish and wildlife enhancement, navigation, and flood control.

Internal Combustion Power Plants

There are two types of internal combustion engines used in power plants: the reciprocating diesel or gasoline engine; and the natural gas turbine or jet engine. Both types of engines are attached directly

to a generator to produce electricity.

The internal combustion power plant has certain limitations but in some situations it has real advantages. The generating capacity of an internal combustion plant is only a small percentage of that of a steam or hydro plant and is not sufficient to produce the electrical energy required for even a small town. However, the internal combustion plant has the advantages of being: (1) comparatively inexpensive; (2) easily located on a small amount of land; (3) remotely controlled and needing no attendant; (4) able to operate at full capacity in a few minutes; and (5) requiring little water for cooling. Because of these characteristics, some utilities use the plants for emergency and peak power service.

Internal combustion plants can be located in urban areas on a site of about one acre. Noise and smoke emitted by the plant may cause disturbance to surrounding neighbors.

Transmission Systems

The elements of a transmission system are:

> (1) all land, conversion structures, and equipment employed at a primary source of supply (generating station . . .) to change the voltage or frequency for the purpose of its more efficient or convenient transmission; (2) all land structures, lines, switching and conversion stations, high-tension apparatus and their control and protective equipment between a generating or receiving point and the entrance to a distribution center or wholesale point; (3) all lines and equipment whose primary purpose is to augment, integrate, or tie together the sources of power supply.[13]

The functions of an electrical system's transmission system are twofold:

1. to convey bulk electric energy from the power source to a delivery point on the distribution system; and

2. to interconnect electrical systems for transfer of energy in case of emergency or in response to a diversity in peak loads.

The transmission system consists of three primary components: (1) a substation at the power plant; (2) transmission lines; and (3) substations at the delivery points of the transmission lines.

The electricity generated at the power plant has a range of from 2.5 kv to 20 kv. While this range is most economical for generation, electricity cannot be transmitted and utilized economically at this level. A substation in the transmission system located at the power plant substantially increases the voltage to the system's transmission voltage level.

Transmission line voltages vary considerably, both between utility companies and within the same electric system. Usually they range from a low of approximately 38 kv to a high of 500 kv. The majority of cross-country transmission lines carry voltages of about 100 or 230 kv. For example, the Georgia Power Company uses transmission voltages of 230 kv, 110 kv, 66 kv, 44 kv and 38 kv. Duke Power, some of whose higher voltage transmission lines tie in with those of the Georgia Power Company, transmits at 250 kv and 100 kv.

The transmission substation is the interconnecting link between the transmission and distribution system. The transmission substation receives the high voltage of the transmission system and converts it to voltages suitable for distribution.

Primary emphasis in this section of the study will be given to

the transmission lines and their characteristics. The other major components of the transmission system, the substation at the power plant and at the terminating point of the system, are discussed in detail in the section on substations.

Location and Right-of-Way Requirements

The majority of transmission system facilities are located in rural and urban fringe areas. The urban-destined transmission lines generally traverse rural areas and terminate at one or more transmission substations ringing the city in the urban fringe. Frequently, however, high voltage transmission lines enter or cut through urban areas to serve large consumers of electricity, such as industrial districts. If possible, these lines are located to skirt and not traverse established residential areas.

The route of transmission lines in urban areas is determined by operational, engineering, and economic factors, although public relations or aesthetic factors may outweigh these in selecting a route.

It is difficult to establish definite criteria for transmission line right-of-way widths, easement practices or location.

Transmission line right-of-way widths vary considerably. The factors influencing the width are the line voltage, type of pole design, and height of surrounding trees. Arkansas Power and Light Company uses widths of 60 feet for 72 kv lines on single poles, 100 feet for H- frame wooden poles with 115 kv, 138 kv and 161 kv, and 125 feet for steel towers with 230 kv. This entire right-of-way width is cleared of trees and tall shrubs to avoid trouble from falling trees and "flashover."[14] In urban areas, the width may have to be less if land is not available

or is too expensive.

There are three methods electric utilities use for acquiring transmission rights-of-way: (1) easements; (2) land ownership; and (3) use of public streets. The utility usually prefers to purchase easement rights if possible. The easement generally specifies the width of right-of-way, provides the right of ingress and egress to the property and enumerates what facilities and activities are prohibited on the right-of-way. Ownership of the right-of-way is used to avoid the problem of policing encroachments on the easement.

An example of a typical transmission easement agreement used by one large electric utility company is found in the appendix.

Occasionally, transmission lines are located on public streets instead of separate rights-of-way. This arrangement furnishes the utility with a free right-of-way but presents other complications. The community may not want transmission lines and poles on certain streets and may object to the facilities in general for safety and aesthetic reasons. In addition, the transmission facilities may have to be relocated if the street is widened.

The location of transmission lines on public streets is subject to supervision by the local governing body of the community. This right of supervision is generallydelegated to one or more engineering departments of the community. The regulatory measures for the location of such transmission lines is discussed in Chapter III of this study.

The community's supervision may be mutually advantageous to the electric utility company and the municipality. A case in point involved the Georgia Power Company and the City of Atlanta. The electric company

selected a route for a transmission line through the city which it felt would be acceptable. However, when the route was checked with the city engineer, it was discovered that the line would traverse a clearance area in the city's urban renewal program. The electric company selected another route when they were informed the transmission lines and poles would interfere with clearance operations and would not conform to the future street pattern.[15]

Generally transmission lines are located overhead with only a few special underground cables. Underground transmission lines are expensive compared with overhead lines, frequently costing 10 to 30 times more. The underground transmission of high voltage requires elaborate conduits filled with gas or oil to cool the wires and prevent condensation.

Effects on Urban Development

Transmission lines have no important objectionable operating characteristics. Occasionally they may cause some radio interference but this is rare.

Frequently, there are strong objections to the appearance of transmission lines and rights-of-way. Adjacent land owners claim the lines and supporting structures are unsightly and decrease property values. When transmission rights-of-way traverse wooded areas, they present an objectionable appearance because of the "swath" created by limiting vegetation in the right-of-way. Although utility officials deny that the transmission lines and rights-of-way decrease property values -- some market analyses seem to support their claim[16] -- there can be no denying that they often have an adverse effect on adjacent property.

One serious objection to the location of transmission lines in urban areas is the large amount of land the rights-of-way require. For example, a 100 foot right-of-way uses more than 12 acres of land for every linear mile.

Distribution Systems

The function of an electrical system's distribution system is to convey electricity from the substation on the transmission line to the consumer.

A distribution system includes the following circuits: (1) the subtransmission circuits; (2) the primary circuits; and (3) the secondary circuits.[17]

Subtransmission circuits, with voltages ranging from 11 kv to 161 kv, transmit electricity to distribution substations or, for some wholesale consumers, to substations located on the consumer's property.

The primary circuits carry electricity between the distribution substations and the final distribution transformers. These circuits are the familiar overhead wires located on almost every street. On these lines voltage may range from 2.3 kv to 34.5 kv.

Secondary circuits consist of the wires that carry electricity from the final distribution transformer to the consumers. The voltage of these circuits is 120/240 volts and is carried by three wires.

The location of secondary distribution lines is governed by the practical limits of energy loss in the conveyance of electricity. Electricity distributed at this low voltage loses a percentage of its energy in a short distance. Thus, it is essential for the distribution transformer to be located within a few hundred feet of the consumer.

In a typical residential area, one transformer serves about eight or ten houses.

Distribution lines in urban areas are generally constructed in one of three locations: (1) overhead on public street rights-of-way; (2) overhead on public utility easements; or (3) underground.

Location Overhead on Public Street Rights-of-Way

Subtransmission lines are frequently located on public streets. Although there is often opposition to this arrangement by the community's citizens for aesthetic and safety reasons, many electric companies prefer this location.

The majority of primary distribution lines are constructed overhead on poles in public street rights-of-way. This location has the advantages of easy access for maintenance and of convenience for street lighting purposes. Street location of distribution lines, however, generally necessitates expenditures for tree trimming and relocation of facilities if the street is widened or its alignment altered.

The utility usually has an easement for tree trimming privileges A ten-foot easement is typical.

Curvilinear streets necessitate the use of guy wires to support distribution poles. Whenever there is a significant curve in the street and hence a change of direction by the electric lines, the poles must be supported on the reverse side by guy wires. These guy wires are usually disliked by the owners of the property on which they are located because they are untidy and pose grass cutting problems.

Location Overhead on Easements

Distribution lines are also located overhead on utility easements.

Overhead subtransmission lines are frequently located on the utility's transmission rights-of-way. In some older residential subdivisions which have alleys, distribution lines are located in the alley rights-of-way. Some newer subdivisions have rear lot line easements where overhead utility lines are placed. Cities having street tree programs prefer utility lines along rear lot lines.

If the rear lot line easement is used, a permanent easement allowing unlimited ingress and egress is obtained by the utility. Tree trimming privileges are also granted in the easement. These easements are usually furnished by the property owners free-of-charge to the utility.

Location Underground

Underground electric distribution lines are favored by many for reasons of: (1) aesthetics; (2) safety; and (3) reliability.

Americans are becoming more conscious of the appearance of electric power facilities. Perry Prentice, former editor of House and Home, a magazine for home builders and developers, wrote:

> The No. 1 eyesore in too many suburbs is not billboards along the highways but power and light poles. Somebody once said if you look at a monstrosity long enough you get so you don't notice it. Maybe some people have been looking at the monstrosity of poles so long that they don't realize how perfectly awful they look. Sometime, take a good look at what poles are doing to square miles of suburban countryside.[18]

The Federal Government has also voiced its concern over the appearance of electric facilities and its approval of underground wiring. The Urban Renewal Administration, Housing and Home Finance Agency, in Local Public Agency Letter Number 278 stated, "Underground placement of utility distribution lines within urban renewal project area is desirable,

and LPA's are encouraged to require it to the fullest extent feasible."[19] President Johnson has urged further research to solve the problems of costs involved in the underground installation of electric lines. This topic was discussed at the White House Conference on Natural Beauty in May, 1965.[20] In July, 1965, the Commissioner of the Federal Housing Agency (FHA) announced that, if economically feasible, electric wiring systems in new subdivisions must be installed underground, to eliminate street-side poles and unsightly overhead wiring.[21]

Electric utility companies too are keenly interested in the appearance -- as well as the safety and reliability -- of their facilities. Periodicals in the electric utility field have had numerous articles on the appearance of electric facilities in an effort to alert utility companies to the sentiment of the public. The following statement which appeared in Public Power magazine is typical.

> To the familiar challenge of providing the most reliable electric service at the lowest possible cost, the utility now must add the challenge of making electric service more attractive.[22]

The safety factor in underground electric facilities is also important. The City of Oakland, in a booklet titled, Moving Ahead From Obsolete Overhead Wiring to Modern Underground rated the saving of human lives and property as the primary reason for burying overhead lines.[23] Dangers from overhead wiring include the very real hazards of electrocution and fire.

An underground distribution system offers reliability not found in overhead systems. The system is free from service outages caused by lightning, ice, sleet, snow, rain and wind storms. Underground facili-

ties also considerably lessen the probability of trouble caused by building fires and by motor vehicles, and other foreign objects coming into contact with the electrical system elements. Although underground facilities are less susceptible to damage, when a fault occurs, it is more expensive and time-consuming to locate and repair than would be a fault on an overhead system. Therefore, when outages occur in underground systems, service may be interrupted for a considerable period of time.

While the underground system is superior to the overhead with respect to aesthetics, safety and reliability, it is also more expensive. The installation cost may vary from 1.25 to 10 times the amount of an equivalent overhead system. For this reason, unless compelled to install facilities underground by city ordinance, electric utility companies usually charge extra for the placement of facilities underground. For instance, if the utility company installs the facilities, it may charge the developer for the additional cost. Some companies will install an underground system only if the development meets their criteria for its designation as a "total electric" development. Some companies, however, prefer underground facilities and do not make a special charge for their installation.[24]

In the trend to install underground electric facilities, the emphasis has been on new residential developments. Only rarely and in special circumstances has underground wiring been placed in industrial or commercial areas outside the central business area. In recent years demand for underground residential systems has come from real estate developers, homebuyers and public authorities. The reason for the

demand is the growing awareness of the benefits inherent in the underground system.

Underground electric facilities in residential areas are frequently installed in easements along rear lot lines. The wires are buried and the transformers "pad mounted" above the ground or completely buried in underground vaults. However, some developers prefer to locate water, sewer, gas, telephone, television cables and electric wiring in one trench at the front property line.[25] Frequently, considerations of accessibility and requirements for street lighting facilities make it more desirable to locate underground electric wiring in street rights-of-way.

Most cities now have underground electric distribution facilities in their downtown areas. Downtown areas have a high density of consumers and a large magnitude of load, requiring numerous circuits for service. To avoid the congestion of overhead wires and obtain the benefits of improved aesthetics, safety, and reliability, the facilities are placed underground. The wires are placed under the street or sidewalks in conduits. Transformers are usually located in the buildings being served or under the sidewalk in vaults.[26] The area for underground wiring generally coincides with the downtown fire district. Many cities require by municipal ordinance that electric facilities be underground in the downtown fire district.

Cities have various policies regarding the installation of electric facilities underground. Legally, according to McQuillin's The Law of Municipal Corporations, " . . . wire using companies may be compelled to place their wires underground or in subsurface conduits, when conven-

ience or the good government of the municipality requires."[27] However, cities have seldom required all electric facilities to be placed underground.

A few municipalities require all future installation of electric facilities underground in residential subdivisions or other designated areas. Some cities, such as Palo Alto, California, stipulate that throughout the entire city all "electric, telephone, and all other utility facilities shall be installed underground . . . ."[28]

Seattle, Washington, has an excellent program for removing overhead wiring in developed residential areas. The city, at the request of affected citizens, designates and establishes Local Improvement Districts. The property owners in the LID pay a special assessment to finance the costs of the changeover from overhead to underground installations.[29] Oakland, California, has a similar program.[30]

Substations

Electric substations are of particular interest to the urban planner. The planner will be more involved with the planning and regulation of this facility than with any other component of the electric power system. Numerous substations are, and will be located in the urban community. The planner should have an insight into the operation of the substation to properly plan for its location and operation.

The function of an electric substation is to convert electricity to a desired voltage and protect the equipment of the electrical system.

The substation is essential to the efficient operation of an electrical system. Electricity can be conveyed over long distances only

at high voltage, else it will lose a large percentage of its power. Yet, electricity cannot be utilized by machinery and appliances at high voltage. Thus the voltage must be reduced to permit its consumption. Substations perform the functions of increasing the voltage at the power plants for transmission and decreasing the voltage of the electricity when it reaches the distribution system.

The electrical components necessary to accomplish the functions of a substation are the transformer, voltage regulator, and circuit breaker.

The transformer converts incoming current to the desired voltage. The voltage regulator provides and maintains a constant voltage. A circuit breaker operates automatically to instantaneously interrupt the electrical circuit if voltage irregularities occur, thereby preventing damage.

In order to mount the components of the substation and to adequately guy incoming and outgoing wires, a supporting framework is essential. The size of this framework is ordinarily proportional to the incoming and outgoing voltage. Many of the connecting lines (buses) in the substation are insulated only by air, thus, the higher the voltage, the greater the distances necessary between buses. This operational characteristic establishes minimum sizes for the different types of substations. Hence, substations cannot be "transistorized", at least in the near future.

There are three types of substations in a typical electrical system: (1) the generation substation; (2) the transmission substation; and (3) the distribution substation.

Generation Substations

The function of the generation substation is to increase the generated voltage to a level suitable for transmission. A common generation voltage is 13.8 kv. In order to efficiently transmit the electricity, the voltage must be increased considerably by the substation, in some cases to 500 kv.

A generation substation is required at the site of every power plant. For all types of power plants except the hydro, the substation is a part of the power plant itself. The generation substation for hydro plants is normally located adjacent to the dam and requires a site of about 1/2 acre.

Transmission Substations

The transmission substation is the terminating point of the transmission voltage and the delivery point of electricity to the distribution system. It is the link between the transmission and distribution systems.

This substation receives electricity at the transmission voltage and reduces it to the subtransmission or distribution voltage. The transmission voltage is usually in the range of 60 kv to 350 kv; the subtransmission, 20 kv to 70 kv; and the distribution, 4 kv to 20 kv.

Transmission substations are typically located in the fringe of an urban area. In some instances, to serve large consumers of electricity, a transmission line will be brought directly into the city and terminate at a substation. A city of about 25,000 with no unusual electrical

demands is normally served by two to four transmission substations. Larger cities may require dozens of substations.

The site for a transmission substation may vary from approximately 1/4 acre to 1 acre in size. Because transmission substations are typically located in undeveloped fringe areas or industrial areas and only rarely in residential areas, little land is needed for buffering. Therefore, the site is usually just large enough to contain the substation components and a protective fence.

Distribution Substations

The most numerous substations in urban areas are the distribution substations. These stations normally receive electricity from the subtransmission circuits and reduce it to a voltage suitable for distribution.

The distribution substation will be located as near the load center of its service area as possible. The substation can normally serve a residential and commercial area of approximately four or five square miles. Thus, substations must normally be located no farther than two or two and one-half miles apart.

Distribution substation sites vary in size from approximately 1/2 acre to 1-1/4 acres. Although the substation components require only 1/4 acre or less, the distribution substation is frequently located in residential areas and requires additional land to buffer the components and conform to setback requirements.

Effects on Urban Development

In operation, substations emit a low, steady hum. This characteristic may cause annoyance to nearby residents. There is no electro-

cution hazard, outside of the area enclosed by the fence provided around substations.

Substations in residential areas are frequently critized because of their industrial appearance. Most utility companies attempt to improve the appearance of their substations. Ordinarily, shrubbery and trees are planted on substation sites. If deemed necessary to maintain good public relations, some utility companies will partially enclose the substation with a decorative fence or other structure.

The next chapter discusses the legal methods of regulating electric power facilities.

CHAPTER III

METHODS OF REGULATING ELECTRIC POWER FACILITIES

Electric utilities are closely regulated at the Federal, State and local level. Most of the controls for utilities regulate financial and business matters. However, there are controls which govern the location, installation and operation of electric facilities.

At the Federal and State levels, three agencies exercise control over electric facilities. They are: the Federal Power Commission (FPC); the Atomic Energy Commission (AEC); and the State Utility Commissions. The FPC issues licenses for non-Federal hydroelectric power plants on navigable waterways. The AEC regulates the location and operation of atomic power plants. In most states a Utility Commission issues certificates of convenience and necessity. This certificate permits a utility to construct and operate electric facilities in a new service area.

The strongest regulation over the location, installation and operation of electric facilities, however, is exercised at the local level. The local controls are of particular interest to the urban planner because the planner may participate in their formulation and implementation. These controls are the franchise, zoning ordinance, special ordinance or resolution regulating electric transmission and distribution lines, subdivision regulations, and the offical map.

Franchise

Most states require an electric utility to obtain a franchise

authorizing them to operate in a municipality. Municipalities are delegated the power to grant franchises by the state in their charters. They have only the regulatory powers specified therein.

The primary purpose of a franchise is twofold: (1) to grant permission for a company to engage in the utility business within the city; and (2) to grant the utility permission to use and occupy public street rights-of-way and property for the erection and maintenance of its facilities.

The franchise is in the form of an ordinance or contract which sets forth the conditions under which the utility will be permitted to operate. It is well recognized that in all franchises, private rights are secondary to the interests of the public. Therefore,

> The power to grant a franchise carries with it the power to impose and exercise such reasonable regulations to its exercise as will effectuate the purposes for which it is granted.[31]

Thus, a utility receiving a franchise is subject to regulation and control by the police power of both state and local authorities.[32]

The municipality's regulation over the use of public streets by a utility is particularly strong. Eugene McQuillin, an authority on municipal law, states that where the consent of a municipality in the form of a franchise must be obtained to use streets, the

> . . . municipality has power to refuse to allow a public service company to use its streets, and its authority is not limited to a reasonable regulation of the method of using the streets.[33]

Many municipalities include stipulations in the franchise agreement which guarantee them adequate control over the location, installation and operation of electric facilities. The following provisions from

a typical franchise granted the Georgia Power Company illustrate desirable stipulations.

> . . . the work of erecting poles and all other work upon the streets and public places of said City shall be done under the supervision of the Mayor and Council (or other legally constituted governing body) of said City . . .[34]

> The said Georgia Power Company . . . shall further, in constructing and maintaining its system of overhead lines, poles, wires and other structures, submit and be subject to all reasonable police laws, rules and regulations of said City for the regulation or control of such structures.[35]

The regulatory powers given the municipality by the franchise are exercised in numerous ways. Generally the powers of "supervision" given the governing body will be delegated to the city engineer, electric engineer, utility engineer, or other specified employee. However, in smaller cities the Mayor or governing body themselves may exercise the "supervision".

The "rules and regulations" exercised by many cities stipulate: (1) the procedure for construction of facilities in public streets; (2) the hours of operation for construction in public streets; and (3) the safety standards for wires on public streets. Additional rules may be adopted by a municipality to meet other needs.

The regulatory powers guaranteed by the franchise make it a valuable tool for the municipality to control the location, installation, and operation of electric facilities. In addition to the legal powers the municipality exercises, the franchise also promotes a spirit of cooperation on the part of the electric utility. This cooperation generally takes the intangible form of "public relations" which are very

important to the municipality because they imply a willingness on the part of the utility to cooperate beyond the specific requirements of the law. For instance, an electric utility may place wiring underground or improve the appearance of its facilities to maintain good public relations and good will with the municipality and its citizens.

Zoning Ordinance

Zoning is the division of a community into districts for the purpose of regulating the use of privately owned land and structures, the height and bulk of structures, the proportion of lot that may be covered by them, and the density of population.

Legality of Regulating Electric Facilities by Zoning

In most states, the electric facilities of a public utility are legally subject to regulation by zoning. Numerous court cases have forcefully stated the municipality's right to regulate public utilities. However, some of these cases have also made it equally clear that the facilities may only be regulated and not banned entirely from the community.

The court stated in Consolidated Edison Co. of New York v. Village of Briarcliff Manor, 208 Misc. 295, 144 N.Y.S. 2d 379 (1955), that "A village may, within reason, regulate public service improvements but may not ban them altogether." A similar decision was rendered in Long Island Lighting Co. v. Griffin, 272 App. Div. 551, 74 N.Y.S. 2d 348 (1951), when the court ruled:

> . . . while a public utility serving the needs of the community may not be excluded therefrom, the precise location within the community may be regulated.

In Niagara Mohawk Power Corp. v. City of Fulton, 8 A.D. 2d 523, 188 N.Y.S. 2d 717 (1958), the opinion of the court was:

> While zoning ordinances are invalid insofar as they absolutely prohibit construction and maintenance of publicly needed utility structures, they may impose reasonable local regulation upon public utilities and the precise location within the community may be regulated . . . .

The courts, in some instances, have dealt specifically with the regulation of electric power plants, transmission lines and substations in zoning ordinances. In People ex rel. Taylor v. Walsh, 140 Misc. Rep. 25, 248 N.Y.S. 753 (1926), the court permitted the exclusion of "electric central station power plants" in business districts.

The court cases reviewed by the author which dealt with transmission lines differed on the legality of controlling this electric facility by zoning. In Kahl v. Consolidated Gas, Electric Light Power Company, 191 Md. 249, 60 A. 2d 754 (1948) a provision in the zoning ordinance requiring a special exception for overhead transmission lines was held valid. However, in Duquesne Light Company v. Upper St. Clair Township, 377 Pa. 323, 105 A. 2d 287 (1954) the court declared that a public utility was not subject to the local zoning provisions with respect to the location of transmission lines.

In another case the court upheld the Zoning Board's denial of a special exception to allow a substation in a restricted residential district (Consolidated Edison Co. of New York v. Gillcrist, 283 App. Div. 718, 127 N.Y.S. 2d 365 (1954)).

Exemption of Electric Facilities from Zoning

In some states, according to E. C. Yokely, an eminent authority

on zoning, there are occasions when the state utility commission may exempt the land of a public utility from local zoning provisions.[36] Arden H. Rathkopf, also an authority on zoning, has written:

> In some states regulation of the location of public utility facilities is taken from the hands of local zoning authorities and placed entirely within the power of the state regulatory body.[37]

In Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, and Pennsylvania, the State's utility commission, after a public hearing, may exempt public utilities from local zoning regulations. In Connecticut, the State commission is also given the power to modify the local zoning provisions.[38]

The validity of the state legislature's entrusting the regulation of public utilities' facilities to a state agency and exempting them from local zoning regulations has been upheld in Wenham v. Massachusetts Department of Public Utilities, 333 Mass. 15, 127 N.E. 2d 791, (1955), Duquesne Light Co. v. Upper St. Clair Township, 377 Pa. 323, 102 A. 2d 287 (1954), and Jennings v. Connecticut Light and Power Co., 140 Conn. 650, 102 A. 2d 535, (1954).

Zoning Provisions for Electric Facilities

To determine the nature and extent of zoning provisions for electric facilities, an examination of 389 zoning ordinances was made. The ordinances dated from 1947 to 1965 and represented cities ranging in population from approximately 500 to 8,000,000 in 49 states and the District of Columbia. Appendix B presents the number of ordinances in each state which were reviewed.

Of the 389 zoning ordinances surveyed, 127 or 33 per cent contain

no specific provisions for electric facilities. Ten of these ordinances specifically state that public utilities' facilities are exempt from the zoning provisions.

Two hundred sixty-two zoning ordinances have provisions which apply to electric facilities. Of these 262 ordinances, 255 or 97 per cent regulate substations. The electric power plant was mentioned in 27 ordinances, transmission lines and distribution lines were mentioned in two of the ordinances reviewed.

It is appropriate that zoning ordinances regulate power plants and substations. These facilities are normally located on non-public or private land and are therefore usually subject to zoning. Because transmission lines are customarily located on public utility easements and distribution lines on public street rights-of-way, they are usually not controlled by zoning.

Districts in Which Power Plants are Permitted

Because of the power plant's operating characteristics, industrial appearance, and effect on surrounding land, it should be treated the same as other heavy industrial operations and permitted only in industrial districts. In all 27 zoning ordinances where power plants are specifically mentioned they are handled in this manner.

If a plant is proposed in an area not zoned for industry, it would be advisable to zone the site and possibly surrounding land for industry. This is desirable because the water and transportation facilities needed for the plant will likely encourage the location of industry in the area.

The remainder of this section on zoning ordinances will deal only with substations.

Districts in Which Substations are Permitted

An examination of the zoning ordinances was made to ascertain the most restrictive district in which substations are permitted.

Seventy-three per cent, or 193 of the 255 ordinances which apply to substations permit them in all zoning districts. This is done in two ways: (1) by specifically stating they are permitted in all districts; or (2) by permitting them in the most restrictive residential district.

In 21 ordinances, substations are not permitted in the most restrictive residential district but are allowed in other residential districts.

Surprisingly, a considerable number of the zoning ordinances surveyed do not allow substations in any residential district. In 30 ordinances, the most restrictive district in which substations are permitted is the commercial district. Eleven ordinances permit substations in only the industrial district.

Substations should be permitted in all zoning districts. Engineering factors may necessitate their location practically any place in the community. In addition, prohibiting the location of a substation throughout an entire district may hinder or prevent the proper operation of the electric system. The court's reasoning in Niagara Mohawk Power Corp. v. City of Fulton, 8 A.D. 2d 523, 188 N.Y.S. 2d 717, (1958), seems to imply that a restriction on the location of a substation would not be permissible. The court stated:

> If the electric company shows that there is public necessity for a substation at a proposed site in a residential section, the zoning ordinance would be held to be invalid insofar as it prevents the company from constructing and maintaining a structure which is reasonably necessary to enable it to perform its public obligation to render safe and adequate service . . .

Zoning Measures for Permitting Substations

A review of the zoning ordinances in which substations are permitted revealed that substations are allowed in specified districts either as a matter of right or subject to a special exception issued by the Zoning Board of Appeals, the Planning Commission, or the governing body after a public hearing.

Matter of Right. A substation permitted as a matter of right may be permitted subject to specified conditions which must be met. However, in 81 ordinances, substations are permitted as a matter of right without conditions. On the other hand, 62 ordinances specify conditions which must be met. The most frequently mentioned, found in 39 ordinances, is that the facility be "essential to the service of the immediate area." The provision that "there be no yard or garage for service or storage purposes" is specified in 11 ordinances. The Jackson, Georgia (no date) zoning ordinance permits substations in residential districts only if they meet the following conditions: (1) the substation is essential for service to the zoning district in which it is permitted; (2) the structures are placed not less than 50 feet away from any property line; (3) the structures are enclosed by a woven-wore fence at least eight feet high; (4) no vehicles or equipment are stored on the premises; and (5) the lot is suitably landscaped.

If the substation is permitted in all zoning districts as a matter of right, adequate conditions should be included in the ordinance. These conditions are especially necessary when the substation is allowed in a residential district. The conditions for the substation should specify: (1) the minimum site size; (2) the type and height of fencing required;

(3) the type and dimensions of planted buffers required; (4) setbacks for substation structures and fencing; and (5) the maximum noise level. In addition, the ordinance should require: (1) that the substation be essential for service to the zoning district in which permitted; (2) that there be no storage or business transactions on the premises; and (3) that the appearance of the substation and required landscaping meet specified standards. Examples that may serve as guides for drafting these provisions are cited in Table 3.

Subject to a Special Exception. The special exception provides that a specified use may be permitted in all or specified districts subject to review and approval by the Zoning Board of Appeals, Planning Commission, or the governing body after a public hearing. The special exception is frequently given other names in zoning ordinances, such as: special permit, conditional use permit or contingent use permit. Table 2 shows which reviewing authorities issue special exceptions in the ordinances surveyed. The reviewing authority is usually specified in the State Zoning Enabling Act.

Table 2. Reviewing Authorities Issuing Special Exceptions

Authority	Number of Ordinances	Percentage
Governing Body	13	12
Planning Commission	17	15
Zoning Board of Appeals	82	73
Total	112	100

In the zoning ordinances surveyed, the provisions set forth relating to the special exception for substations vary considerably. Sixty-four ordinances have only general criteria to guide the planning commission, governing body, or zoning board of appeals in granting the exception. Forty-eight ordinances, however, specify conditions that must be met before an exception is granted. Common to all the ordinances is the condition that a public hearing be held before the special exception is granted. All of the ordinances provide that the designated reviewing authority may stipulate additional conditions which must be met.

Table 3 illustrates some conditions for substations requiring a special exception permit which were found in the zoning ordinances surveyed.

It is not advisable that the community use the special exception to regulate power plants and substations. The special exception has several shortcomings. First, the decisions of the reviewing body may be arbitrary and subjective. Second, the utility is not assured of being granted a permit even if it meets the conditions set forth. Third, the reviewing body may render its decision to satisfy the citizens at the public hearing, ignoring the real need of the utility for a substation at a particular location. Instead, the substation should be permitted as a matter of right subject to adequate conditions. This method provides sufficient safeguards for the community and eliminates the shortcomings associated with the special exception.

Special Ordinance or Resolution Regulating Electric Lines

Some cities and counties have adopted ordinances or resolutions

Table 3. Examples of Conditions for Substations Permitted as a Special Exception in Zoning Ordinances

Feature	Municipality and Date of Ordinance	Requirements
Necessary for the public convenience	Fairbanks, Alaska (1961)	The location of necessary appurtenances to utility systems such as . . . sub-stations and other similar establishments necessary to the public convenience.
Site size	Bismark, North Dakota (1958)	The use is located on a lot no smaller in area than the minimum area specified in the district in which it is located for any principal use.
Appearance	Pullman, Washington (1953)	Electric substations . . . provided such buildings shall conform to and harmonize with the surrounding buildings as to type of architecture . . .
	Fairbanks, Alaska (1961)	Design. That the design be such that the installation will be compatible with the neighborhood.
Landscaping	Greenville, Missi-ssippi (1961)	Open spaces on the premises shall be suitably land-scaped and maintained.
Setbacks	Darien, Connec-ticut (1952)	Static transformer stations provided... the transformer stations and/or transformer mats are located not less than 50 feet from any interior line.
Fencing	Alexandria, Vir-ginia (1951)	. . . static transformer stations if enclosed by a solid masonary wall not less than 8 feet high.

(continued)

Table 3. Examples of Conditions for Substations Permitted as a Special Exception in Zoning Ordinances (Concluded)

Feature	Municipality and Date of Ordinance	Requirements
Buffer Strip	Lavonia, Georgia (1962)	Electric transformer stations . . . provided that: There is a planted buffer strip at least 10 feet wide along the side and rear property lines.
Noise	Rochester, New York (1958)	The level of noises emanating from such installations, measured at the property line shall normally not exceed sixty (60) decibels. This limitation does not include those portions of the property bounded by streets, highways or alleys.
No storage	North Wilkesboro, North Carolina (no date)	Electric substations ... provided that no vehicles or equipment are stored on the premises... .
No business office	Mesa, Arizona (1962)	Public utility buildings ... provided, that no public business offices and no repair or storage facilities are maintained therein.

dealing with the installation and maintenance of electric lines by electric utilities. These ordinances or resolutions usually designate a local official to control the placement and location of wires and poles for the safety and convenience of the public. For example, the City of Atlanta passed an ordinance with a section which allows the Superintendent of Electrical Affairs to:

1. regulate and determine the placing of wires so as not to cause fires or accidents endangering life or property;

2. direct the placing of poles and wires in streets, alleys, and other public places of the City to cause as little obstruction as possible to public travel and private use and enjoyment of adjacent property; and

3. compel the removal of superfluous poles in the streets, alleys and public places of the City.[39]

Ordinances and resolutions may require electric utilities to install wiring underground. Palo Alto, California, adopted an ordinance which requires that all newly installed electric wiring be placed underground. Milwaukee, Wisconsin, in 1963 specified that all electric utility lines on municipal property supplying service to municipal buildings should be installed underground wherever feasible.[40] Ordinances are also used to designate districts for underground wiring.

In addition, ordinances and resolutions are used to initiate programs for the removal or relocation of overhead electric lines in conjunction with street widening and paving work.

Subdivision Regulations

Land subdivision regulation is the guidance of land subdivision development by a public authority, enforced through the power to withhold the privilege of public record from plats that do not meet established requirements and standards.

Subdivision regulations may specify: (1) minimum requirements for streets and easements for utilities; and (2) the installation of utility improvements within new subdivisions.

Subdivision regulations govern the installation of distribution lines by specifying the size and the location of utility easements. Easements for distribution lines are generally required along rear or side lot lines. The following is an excerpt from the Fremont, California (1958) subdivision regulations which may be considered as typical for utility easements.

> Easements. Utility easements, not less than ten (10) feet in width shall be provided within the subdivision where required for public utility purposes. All overhead public utility facilities normally shall be located in rear or side yard easements . . . .

Subdivision regulations may also designate where underground wiring is required. For instance, the subdivision regulations of Berkeley, California (1962) require the installation of electric distribution wires underground in all areas of the City other than those classified as Special Industrial Districts or Industrial or Manufacturing Districts.

The subdivision regulations of Hammond, Indiana (1953) include a provision which requires a subdivider to submit preliminary plans for utility easements to the local telephone, electric and gas companies, and city water and engineering departments for their recommendations and

approval. This is an excellent method of insuring that utility easements meet with the approval of utility companies before they are accepted by the municipality.

Official Map

> An "Official Map" is a term used to designate a map which shows the precise location of existing and proposed streets. In some cases it includes sites for public buildings and public open spaces. The Official Map Ordinance protects the planned future sites shown on the Official Map by prohibiting the erection of structures within them.[41]

As of 1961, nineteen states had some form of general enabling legislation authorizing local governments to adopt an Official Map and Ordinance. The legislation in all of these states permits the reservation of future street rights-of-way. Seven of the 19 states also authorize the reservation of sites for other public uses by the local government. However, none of the legislation mentions or implies that public utilities are a public use. Only four states, California, New Jersey, Pennsylvania, and Wisconsin make extensive use of the Official Map and Ordinance.[42]

The reservation of electric transmission rights-of-way and substation sites by the Official Map and Ordinance merits further consideration. If the Official Map and Ordinance are to be used for the reservation of transmission rights-of-way and substation sites, adequate state enabling legislation must be adopted. The legislation should provide the following:

1. The local governing authority, by use of the Official Map and Ordinance, has the authority to map and prevent the construction of

structures within future transmission rights-of-way and substation sites of a public electric utility.

2. In cases of hardship where the owner of property has been deprived of the sale or use of his property by the transmission rights-of-way or substation sites on the Official Map and Ordinance, the local appeal body may: (1) permit the sale of the property free and clear of the restrictions imposed by the Ordinance; or (2) order the electric utility to institute purchase or condemnation proceedings within a given time period.

3. The designation and reservation of transmission rights-of-way and substation sites on the Official Map and Ordinance is deemed a public purpose for which the public electric utility can condemn the rights-of-way and sites in advance of actual need by use of its power of eminent domain.

The electric utility should contact the urban planner if it would like transmission rights-of-way and substation sites reserved by the Official Map and Ordinance. The urban planner and utility planner can locate lines and sites so that they will meet the needs of the utility and will not be harmful to surrounding land. The urban planner can then recommend to the governing authority that the jointly accepted rights-of-way and sites be reserved by the Official Map and Ordinance.

Reservation of rights-of-way and sites would aid both the community's citizens and the electric utility. If land were reserved for transmission lines and substations, citizens would have advance knowledge of where these facilities would be located so they could plan surrounding land accordingly and the electric utility could reduce its land acquisition costs.

CHAPTER IV

PLANNING FOR ELECTRIC POWER FACILITIES

Electric power facilities must serve urban areas. Frequently, however, these facilities are not planned so that their location, installation and operation are of maximum benefit to both the electric utility company and the community.

In addition to the engineering and economic studies normally undertaken by the electric utility, other studies should be undertaken before electric facilities are located in urban areas. This chapter will discuss some of the studies which should be made before the final site for a power plant or substation or the right-of-way for transmission lines is selected. Policies for the placement of distribution wires underground will be considered as well as policies when an area that is annexed by the city is served by an electric utility different from that serving the city.

Power Plants

In addition to the engineering and economic studies made by the utility company to determine a suitable location for a power plant, there are community factors that should be considered. The community is concerned with the plant's effect on community facilities and the existing and future development of the surrounding area. The electric utility is concerned with the number and type of customers in the vicinity of the plant and with the community's reaction to the location of the plant.

The urban planner can be of assistance to the electric utility planner in evaluating sites for a power plant. The urban planner can help estimate the effects of the plant on community facilities and the adjacent areas. He will have knowledge of what type of development is expected in the vicinity of the plant. He also may assist in planning the future development of the area surrounding the plant.

In evaluating alternate sites for the location of a steam power plant, the effect on community facilities should be determined. Will the plant's smokestacks be in the path of existing or proposed airport approach zones? What effect will thermal pollution from the hot water effluent of the plant have on the receiving stream with respect to its use for boating and swimming? What will be the effect of the effluent on the stream's aquatic life, self-purification capacity, and suitability for a municipal water supply?

The effects on the surrounding area of a fossil-fuel steam plant's fly ash emission should also be determined. The areas significantly affected can be delimited by engineering studies. Damage from fly ash to present development in the affected area should be estimated. "Tolerable limits" of fly ash concentration for different types of development: industrial, commercial, residential, and agricultural should be established and mapped.

If possible, a site for the plant should be selected where the surrounding area can be developed for industry. The fly ash would probably not adversely affect industrial operations. In addition, adjacent areas would probably be suitable for industry because of the level topography, soil characteristics, and the availability of water and transpor-

tation facilities. The industry might be charged a lower than usual electric rate if near the plant. If a railroad line or heavy duty roadway must be constructed to serve the power plant, they should be planned so as to promote industrial growth in the area.

Transmission Lines

If transmission lines must be routed through urban or developing areas, a number of alternate routes should be selected and studied to determine: (1) the amount, type, and value of land they will occupy; and (2) the effect on surrounding area. Existing transmission rights-of-way should be examined periodically to determine whether relocation of certain portions of the lines would be beneficial to the utility and the community.

The urban planner can be especially helpful in selecting a route for transmission lines in developing areas. The planner will have knowledge of what type of development is expected along the routes being studied and where proposed Interstate Highways, Urban Renewal Projects, highway widenings and other community projects will be located. This advance consultation with the urban planner will produce better public relations for the utility and save the utility the expense of relocating facilities.

Transmission line rights-of-way, if not carefully located, remove from development a considerable amount of land which could be used for more productive purposes. This is especially true in urbanizing areas where developable land is scarce or at a premium. Therefore the amount of developable land which transmission rights-of-way occupy should be

kept to a minimum. The advantages of transmission lines being located in flood plains, on existing rights-of-way of railroads and other utilities, and on street rights-of-way should be investigated. Routing lines in these areas, where possible, would probably result in financial savings and a better public image for the utility. The policies of other utilities, especially railroads, with regard to permitting electric transmission lines on their rights-of-way should be investigated. The community should determine along what public streets it will permit the utility to construct transmission lines and what restrictions will be placed on the use of the streets.

When evaluating routes for the location of transmission lines, studies should be made to determine the effects on the surrounding area. Property maps will show the alternate routes' effects on land parcels and the number of unusuable remnants created. Routes proposed near physical features such as creeks, rivers, railroads and highways should be carefully checked to see that small or shallow undevelopable building sites are not created.

If adequate state enabling legislation were passed, proposed transmission rights-of-way might be placed on the Official Map. This would encourage the utility and community to jointly work out transmission routes which would be of the maximum benefit to the community and the utility. Advance mapping and protection of rights-of-way against encroachments would have obvious advantages to the utility. In addition, developers would know the exact location of future transmission lines so development could be planned accordingly.

In many instances, it might be advantageous to the utility and

the community if existing transmission lines were relocated. The electric utility itself might initiate the abandonment of portions of its transmission rights-of-way if it is profitable to sell or lease the development rights. For example, the utility should study its transmission rights-of-way in expensive industrial areas to see if the costs of abandonment and relocation would be profitable. In some instances, if a transmission right-of-way bisects a choice site for a public housing project, the community might request the utility to abandon the route. If the community requests abandonment it should negotiate with the utility to determine its share of the abandonment and relocation costs. As an alternate right-of-way, the city might permit the utility to use public streets for the relocated transmission lines.

To decide on the transmission route the community would prefer, it should consider three factors. These factors are: (1) the amount of land taken from development, especially scarce or valuable land; (2) detrimental or beneficial effects on surrounding land; and (3) community attitudes toward each route. Ideally, of course, the community would prefer the route which would be the least detrimental or the most beneficial.

The community should not overlook the possibility of utilizing proposed and existing transmission rights-of-way. Examination of transmission easement agreements should be made to determine what restrictions there are on the use of transmission rights-of-way. Typically the major restriction is that no buildings or structures other than fences may be erected in the easement. Portions of the transmission line rights-of-way might be used for designated open spaces, football fields (without

stands), tennis courts, and easements for other utilities.

Underground Distribution Facilities

The planner should play a vital role in formulating policies and priorities the community should adopt for the underground installation of distribution wires. Studies should be made to determine: (1) the areas in which underground facilities should be installed; and (2) the cost difference between the overhead and underground system.

Areas which should be given a high priority for the initial location or relocation of distribution wiring underground include: the downtown or central business district; scenic, historic, and tourist attractions; Urban Renewal Projects; and new residential subdivisions.

In comparing the total cost for overhead and underground facilities, two items of expense should be estimated: the cost of the initial installation; and the operational and maintenance costs over the years.

The adoption by the community of policies and priorities for underground electric wiring would be very helpful to the utility. The electric utility would know what was expected of it and could schedule its work accordingly.

Substations

The distribution substation must be located at the approximate load center of its service area. Some of the information which is part of the urban planning process can be of assistance to the electric utility in delimiting the approximate service area of the substation. By utilizing this information, the utility can anticipate where and when substations will be needed.

The urban planner can assist the utility by furnishing information on the type of land use and density of development which will likely occur in a given area in the future. Knowledge of the location, number and type of customers, combined with the utility planner's information of approximately how much electricity is required per type of customer can be used to delimit service areas and locate substations.

The approximate timing of development can also be anticipated by the urban planner from his knowledge of when and where municipal utilities such as water and sewerage systems will be installed. These municipal facilities promote, encourage and allow full development to take place.

With the knowledge of approximately where, what type, and when development will occur, the electric utility can negotiate with developers for substation sites as land is subdivided. If there is adequate state enabling legislation, substation sites may be placed on the Official Map for reservation. Advance reservation of substation sites would have the advantage of notifying builders that a substation would be on the site selected and development could be planned accordingly.

The electric utility should also investigate the possibility of locating substations in conjunction with community facilities such as water and sewerage pumping stations and on shopping center sites. The shopping centers and distribution substation have nearly the same locational requirements and both generally serve one residential neighborhood.

The effect of the substation on adjacent property should be considered before a site is selected. Objections to the location of a substation in a residential area because of the audible hum and

industrial appearance are frequently expressed. However, if substation sites are carefully selected, are of adequate size, and have sufficient buffers, the adverse effects on adjacent residential property will be nill.

Annexation

Lastly, the urban planner is frequently involved when a municipality annexes areas served by an electric utility different from that serving the city. This presents the problem of which system will serve the annexed area. In Georgia, this problem has been solved in two ways. First, if the annexed area is served by the Georgia Power Company (investor owned), a municipality operating its own electric system may purchase the Power Company's facilities in the annexed area within 90 days after a request to the Power Company. This agreement was worked out by the Power Section of the Georgia Municipal Association and the Georgia Power Company.[43] Second, if the annexed area is served by a Rural Electrification Administration (REA) Cooperative, the state legislation provides that the REA may continue to operate in the annexed area and serve any new customers within 300 feet of its lines. However, the REA must pay property tax and an amount in lieu of taxes equivalent to the amount an investor-owned electric company would pay the city.[44]

APPENDICES

APPENDIX A

EXCERPTS FROM TRANSMISSION EASEMENT FOR RIGHT-OF-WAY

For and in consideration of the sum of _____ ($_____) Dollars, in hand paid by GEORGIA POWER COMPANY, the undersigned, _____, does hereby grant to said Company, the right to, from time to time, construct, operate, maintain and renew electric transmission, distribution and communication lines, with necessary or convenient towers, frames, poles, wires, fixtures and appliances upon, and with overhead and underground protective wires and devices in connection therewith upon or under, a strip of land _____ (_____) feet in width, _____ (_____) feet on each side of a center line, more fully located and described below; together with all rights and privileges necessary or convenient for the full enjoyment or use of said strip for the purposes above described, including the right of ingress and egress to and from said strip and the right to cut away and keep clear all trees and undergrowth and to remove all obstructions now on said strip or that may hereafter be placed thereon and trees adjacent thereto which now or may hereafter injure or endanger any of the works on said strip, and the right to install, maintain and use anchors or guy wires on lands adjacent to said strip.

The center line of said strip is more fully described as follows:

(Legal Description of Property)

The center line of said strip being shown on plat made by or for said Company, and on file in the Office of said Company.

Said Company, its successors and assigns, shall pay or tender to the owner thereof a fair market value for any growing crops, fruit trees or fences cut, damaged or destroyed on said premises by the employees of said Company, its agents, successors, or assigns, in the construction, reconstruction, operation and maintenance of said transmission lines, except those crops and fruit trees which are an obstruction to the use of the right-of-way as herein provided or which interfere with or may be likely to interfere with or endanger said lines or their proper maintenance and operation, provided the Grantors herein shall give the Company written notice thereof within thirty (30) days after said alleged damage shall have been done. Any growing crops or fruit trees so cut or damaged on said premises in the construction, reconstruction, operation and maintenance of said transmission lines remain the property of the owner of said crops or fruit trees.

It is agreed that part of the within named consideration is in full payment for all timber cut or to be cut in the construction, operation and maintenance of said transmission lines; timber so cut to remain the property of the owner thereof.

The Grantors reserve the right to use the land hereinbefore described upon which the said transmission line or lines may be erected, for agricultural or any other purposes not inconsistent with the rights hereby granted, provided such use shall not injure or interfere with the proper operation, maintenance, or repair of, or extensions or additions to, the said line or lines; and provided further, that no buildings or

structures other than fences may be erected upon the said strip of land.

Said Company shall not be liable for, or bound by, any statement, agreement or understanding not herein expressed.

TO HAVE AND TO HOLD forever, unto said Company, its successors and assigns, the rights herein granted, which shall be a covenant running with the title to the lands above described.

(Signatures)

APPENDIX B

NUMBER OF ZONING ORDINANCES REVIEWED BY STATE

State	Number of Ordinances	State	Number of Ordinances
Alabama	14	Montana	2
Alaska	6	Nebraska	3
Arizona	5	Nevada	0
Arkansas	3	New Hampshire	4
California	34	New Jersey	5
Colorado	11	New Mexico	3
Connecticut	13	New York	15
Delaware	1	North Carolina	10
Florida	24	North Dakota	2
Georgia	13	Ohio	13
Hawaii	3	Oklahoma	6
Idaho	2	Oregon	4
Illinois	16	Pennsylvania	15
Indiana	15	Rhode Island	4
Iowa	3	South Carolina	5
Kansas	7	South Dakota	1
Kentucky	12	Tennessee	18
Louisiana	3	Texas	14
Maine	4	Utah	3
Maryland	4	Vermont	3
Massachusetts	10	Virginia	10
Michigan	11	Washington	6
Minnesota	4	West Virginia	3
Mississippi	5	Wisconsin	10
Missouri	4	Wyoming	2
		U.S.A. TOTAL	389

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